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Preliminary Evaluation of Crude Oil and Vapor Phase Analytical Findings

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Prepared For:

Unified Command

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1.0 Description of the MC 252 Crude Oil – weathered water phase

Deepwater Horizon crude is a “light sweet” oil. “Sweet” is a description of how much sulphur is in the oil. In the 19th century, oil workers would taste and smell small amount of oil to determine its quality. Crude oil with low sulphur content had a mildly sweet taste and pleasant smell. Therefore, “sweet” crude is a low sulfur crude oil.

When crude oil is released in the environment, its composition changes as a result of “weathering.” Weathering processes include evaporation and others. Evaporation occurs mainly during the first 24-48 hours after release which greatly reduces the amount of volatile components. Some crude oils may lose up to 40% of their volume due to evaporation in the first few days after a release. The substance remaining after evaporation is called weathered crude oil. Thus, the composition of any released product remaining in the affected area is likely to be substantially different than the originally released crude oil. Due to the weathering process, the remaining product is generally considered to have less potential for causing adverse health effects.

A sample of MC252 weathered oil collected on April 27, 2010 was analyzed by Zymax Laboratory in Escondido, CA for whole oil analysis. The carbon range associated with the whole oil analysis is carbon-3 (C3) to carbon-44 (C44). In addition, the sample was analyzed by B&B Laboratories in College Station, Texas for polyaromatic hydrocarbons (PAHs).

The lowest molecular weight hydrocarbon detected in the whole oil analysis was the alkane *n*-C14 (labeled on the attached chromatogram). Naphthalene, a volatile PAH compound, elutes earlier than *n*-C14 and was not detected by Zymax but was present above detection limits at only 0.1 mg/kg oil using a more sensitive PAH method by B&B. More volatile compounds, including benzene, toluene, ethylbenzene, and xylenes were also undetected.

While hydrogen sulfide was not measured in the liquid weathered sample, it has been analyzed for and not detected hundreds of times in air immediately above both the fresh oil and weathered.

1.1. Zymax Laboratory Results

Results from Zymax Laboratories indicate the weathered oil is comprised of aliphatic and cyclic hydrocarbons greater than C14. The results indicate that carbon compounds smaller than C14 are not detected and indicates the volatile fraction of the oil was rapidly lost to evaporation prior to sampling.

The chromatogram presented in Figure 1 illustrates the distribution and relative abundance of aliphatic hydrocarbons in the weathered oil and that the lowest carbon number straight chain aliphatic hydrocarbon detected is C14. Lower carbon number aliphatics were analyzed for but not detected.

1.2. B&B Laboratories Results

Results from B&B Laboratories indicate that naphthalene, the lightest and most volatile cyclic hydrocarbon tested for in the PAH analysis, was detected slightly above the 0.1 mg/kg oil detection limit.

The chromatogram presented in Figure 2 illustrates the distribution and relative abundance of cyclic hydrocarbons in the weathered oil. Note that the concentration of naphthalene relative to the heavier cyclic hydrocarbons is so low that the bar graph for naphthalene does not appear.

2.0 Chemistry of Crude Oil Vapors from the MC 252 Deepwater Horizon

CTEH is in the process of identifying the chemical composition and concentration of crude oil vapors present in air from “fresh” crude oil based on laboratory data. The data obtained from this study can be used to help guide decisions regarding the potential chemicals of concern in crude oil vapor to the public and to workers engaged in cleanup activities. First we describe the chemical composition of two water samples collected by Entrix from “weathered” crude oil followed by a summary of air data CTEH collected immediately above fresh oil.

2.1. Description of the MC 252 Crude Oil –vapor phase

On May 5, 2010 at approximately 1520 hours CST, two 6L SUMMA canisters were collected approximately 3 feet above the surface of fresh crude oil (photos below). Samples were sent to Pace Analytical in Minneapolis, MN for analysis using EPA Method TO-15 plus a request to identify what is called tentatively identified compounds or TICs. This method is used to identify the volatile phase of petroleum hydrocarbons.

On May 10, 2010, 4 SUMMA canisters and water samples were also collected from the Q-4000 (drill rig adjacent to the leaking well), and the BOA SUB C, ROV ship that is positioned directly above the source oil. Air samples were collected immediately above the surface of fresh crude and on the deck of the ship and vessel. These samples were sent for laboratory analysis and the results are given in Table 1. Sample number 3 was collected immediately above the surface of crude oil by the Q4000. Sample 4 was collected from the deck and is representative of worker locations. Sample number 5 was collected immediately above the surface of crude oil by the Boa Sub C which is the ROV ship above the leaking crude. Sample 6 was collected from the deck and is representative of worker locations. Note sample 6 was also collected in an area where combustion engines were operating and other petroleum sources were present.

2.2. Results

The results of chemical analysis of the air immediately above the fresh crude oil is given in Table 1. The results are consistent with crude oil vapors travelling through more than a mile of seawater where the more water soluble compounds tend to go into solution and the less soluble, smaller molecular weight compounds volatilize into the atmosphere upon reaching the surface. Note that the complete TO-15 list and TIC analysis was requested and analyzed. However, the data below are the results for only the compounds detected in either of the two samples.

Table 1 Air Sample Results collected immediately above the fresh crude oil

Compound Name	Sample 1 Conc (ppbv)	Sample 2 Concentra-tion (ppbv)	Sample 3 Conc (ppbv)	Sample 4 Conc (ppbv)	Sample 5 Conc (ppbv)	Sample 6 Conc (ppbv)
Analytical Results						
Benzene	4.8J	ND	ND	ND	ND	6.4
Cyclohexane	107	204	36.4	5.9	14.9	372
Dichlorodifluoro methane	ND	ND	ND	1.6	1.4	ND
Ethanol	41.1	6.8	ND	ND	ND	ND
Ethyl acetate	162	ND	ND	ND	3.3	ND
Ethylbenzene	6.1J	8.9	10.8	ND	1.6	69.1
4-Ethyltoluene	4.1J	7.8	17.8	ND	ND	131
n-Heptane	143	302	52.0	10	19.7	237
Toluene	25.4	22.6	14.3	ND	4.6	99
1,2,4-Trimethylbenzene	13.1	29.7	92.4	4.7	3.0	145
1,3,5-Trimethylbenzene	4.7J	11.4	31.2	1.9	ND	63.6
m&p-Xylene	29.1	50.4	70.8	3.7	8.0	237
o-Xylene	9.1	15.4	27.3	1.5	2.6	109
n-Hexane	ND	300	50.9	10.2	22.6	222
2-Propanol	4.6J	ND	ND	ND	ND	ND
Naphthalene	3.5J	11.9	19.2	ND	ND	ND
Propylene	17.6	23.1	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	2.0	ND	ND
THC as Gas	3730	5370	5550	847	645	15200
Tentatively Identified Compounds						
Carbon dioxide	314	66.0				
Isobutane	63.6					
Butane, 2-methyl-	43.4	68.4			13.8	
Pentane, 2-methyl	40.4	76.4		5.51	13.1	
Pentane, 3-methyl-					6.26	13.2
1H-Tetrazole, 5-methyl-	41.8				8.42	
Pentane, 3-ethyl-3-methyl-	34.8					
Hexane, 3-methyl-	134				6.42	
Cyclohexane, methyl-	108	218	78.0	1.08	25.9	38.0
Hexane, 2,5-dimethyl	32.5					
Cyclohexane, 1,3-dimethyl-	51.8	113			12.0	1330
Cyclohexane, 1,3-			55.4	7.94		694

dimethyl- ,						
Octane	83.6	174	98.7	13.7	21.5	1620
Cyclohexane, 1,2-dimethyl-	19.0				6.80	
Cyclohexane, ethyl-	28.0	61.6			6.13	1400
Heptane, 2,3-dimethyl	21.8	53.6				
Octane, 4-methyl-	32.0		95.7		11.2	
Nonane	66.4		186	22.1	21.4	
Cyclohexane, propyl-	33.5	78.5	134	12.4	9.96	1110
Unknown	26.4	77.2	83.5	102	1.5	8.38
Unknown			56.7	8.93		
Unknown			59.4	5.5		
Decane	47.4	118	191	22.5	11.2	704
Cyclohexane, butyl-	20.8					
Butane		47.5				
Pentane		88.8				
Cyclopentane, methyl-		56.5				16.2
Hexane, 2-methyl-		62.5			5.86	
Pentane, 2,3,4-trimethyl-		141				
Cyclohexane, 1-ethyl-2-meth		59.9				806
Cyclohexane, 1-ethyl-2-meth		54.8				
Undecane		97.5	220	18.2	6.01	
Dodecane		65.6				
Benzene, 1-ethyl-2-methyl-			69.8			731
Cyclohexane, 1-methyl-2-pro			91.6	5.95		
Benzene, 1-ethyl-3-methyl-			60.9			
Cyclohexane, butyl-			81.2	7.25		
Benzene, 1-methyl-3-propyl			73.0			
Benzene, 1-methyl-4-(1-meth			67.1			
Benzene, propyl-						950
Naphthalene,			67.1			

decahydro-2-me				
Naphthalene, decahydro-2-me	98.5			
Cyclohexane, pentyl-	85.3	5.38		
Naphthalene, decahydro-		6.12		
Cyclopentane, 1,2,3-trimeth		1.08		7.87
Cyclopentane, 1,2,4-trimeth				8.16
Heptane, 2-methyl-		5.53	9.48	
Cyclohexane, 1,4-dimethyl		6.52		528
Nonane, 2-methyl		5.90		
Benzene, 1-methyl-2-propyl-		5.38		
Cyclopentane, 1,2-dimethyl			5.35	
Cyclopentane, 1,3-dimethyl-				13.7
Hexanedioic acid, .alpha. –k			4.63	
Hexane, 3-ethyl-				390
2,2-Dimethyl-1-oxa02-silacy				987
Undecane, 2,5-dimethyl-				371

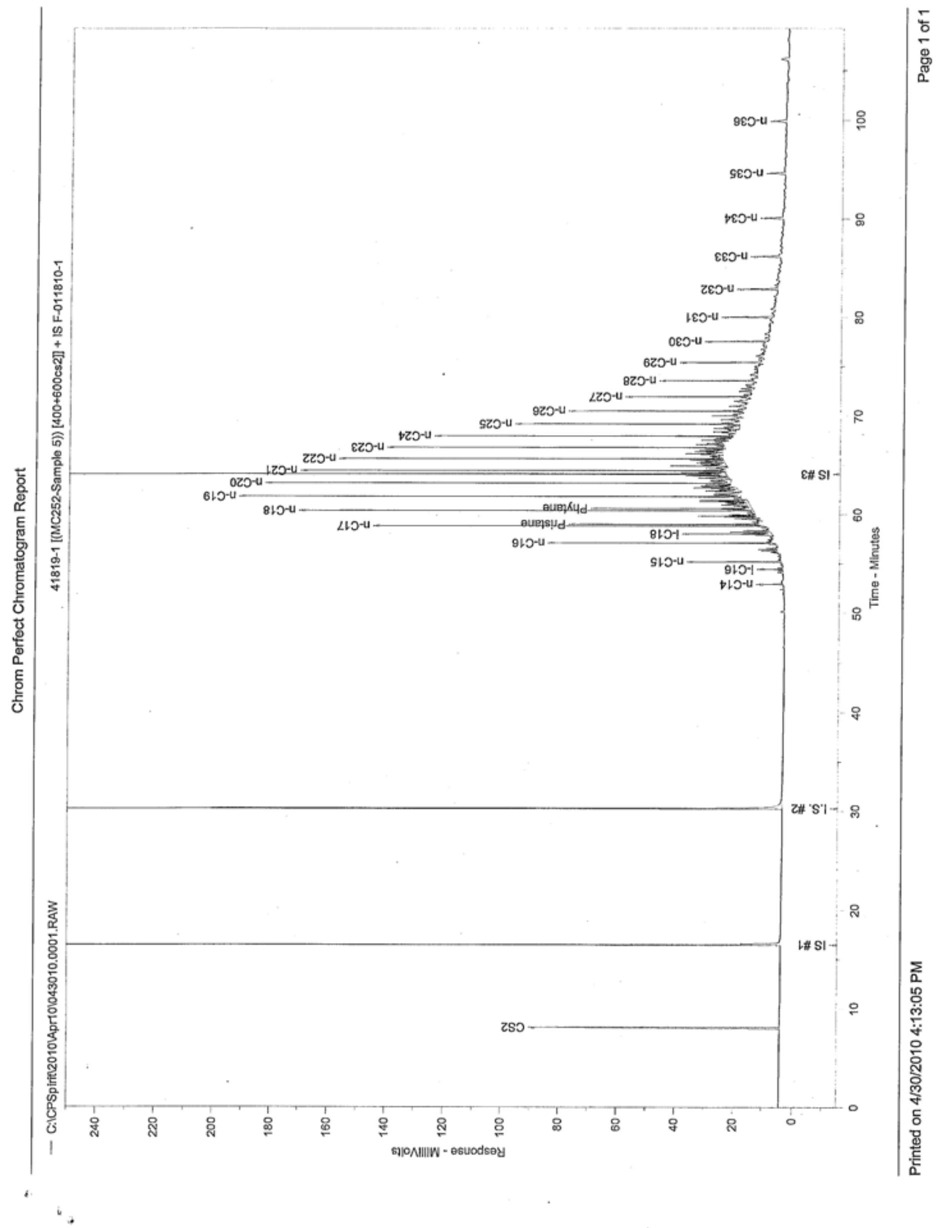

Figure 1

Zymax Laboratory Weathered Crude Analysis Chromatogram

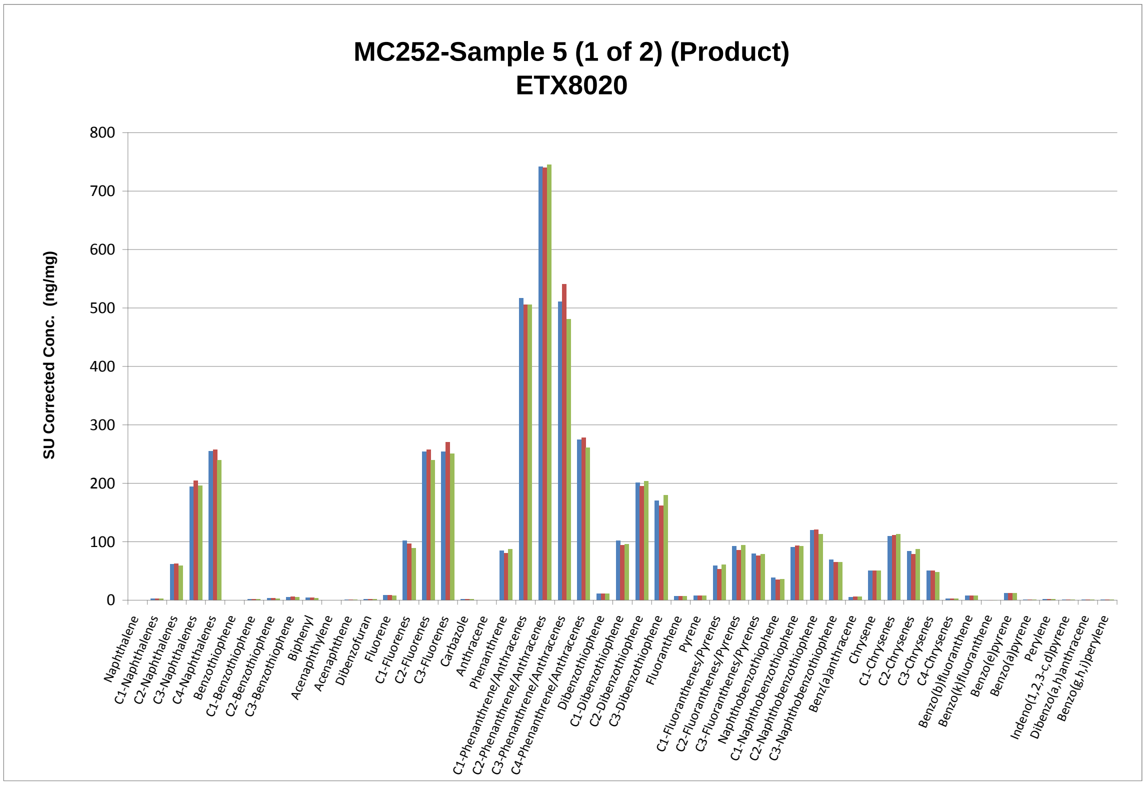

Figure 2

B&B Laboratories Quantitative PAH Analysis Chromatogram of Weathered Crude